Remarks:

At the outset, the applicant would like to thank the Examiner for indicating allowable claims 2, 10, 11, 17, 25, and 26. New claims 30 and 31 are claims 2 and 17 rewritten in independent form. Claims 31 are in this case. Claims 1-9, 12, 13-16, 18, 19-24, 27, and 28 are rejected under 35 U.S.C. §103.

Several of the claims have been corrected and amended for clarity. Claim 1 has been amended to call for the coreless transformer to be fabricated in or on the layers of a printed circuit board, an important aspect of the invention. The word "voltage" was introduced to give antecedent basis for dependent claims 12 and 13. Here, voltage refers to the smoothed rectified pulses (as for example, the voltage across C60 in Fig. 2). Claim 2 has been amended to clarify that the bias circuit generates the pulses. Claims 12 and 13 have been amended for clarity. The driver and coreless transformer limitations of claims 12 and 13 are already in claim 1 and therefore redundant in these claims.

Means plus function claim 16, has been amended to be similar to claim 1. Claim 17 has been amended to be similar to claim 2. And, the amendments to claims 27 and 28 are similar to those made to claims 12 and 13.

Method claim 29 has been re-drafted for clarity. The control circuit referenced to the output side is correlated to the word controller so that the claim better matches the exemplary circuit of Fig. 2.

Two minor clerical errors are corrected at page 5, lines 18-19 in the Specification (paragraph [0014]). The two references to capacitor 506 should be to capacitor 505. Support for these corrections is found in Fig. 4A.

No new matter is added by these corrections and amendments.

REJECTION UNDER 35 U.S.C. §103:

Claims 1-9, 12, 13-16, 18, 19-24, 27, and 28 are rejected under 35 U.S.C. §103 as obvious over U.S. Patent No. 6,434,025, "*Power Supply Unit*", issued August 13, 2002 to Shirai, et al. (hereinafter "Shirai") in view of U.S. Patent No. 5,579,202, "*Transformer Device*", issued November 26, 1996 to Tolfsen, et al. (hereinafter "Tolfsen").

These rejections are believed inapplicable to the claims as amended.

It is well established in order for a combination of references to make a claimed invention obvious, the references must teach or suggest every limitation of the claim. Furthermore, a suggestion to make the proposed combination must be found in the references. In re Vaeck, 947 F. 2d 488, 493 (Fed. Cir. 1991). Claim 1 as amended, calls for an isolated coreless transformer formed in or on layers of a printed circuit board. None of the references teach or suggest this limitation.

Switchmode power supplies have a primary input side and a secondary output side. The principle of operation of these very efficient supplies is that a DC source is converted to an AC power signal and then energy is transferred from the primary to secondary side of the converter by a power transformer where it is rectified back to a DC voltage. Because the frequency of the AC power signal is relatively high, the power transformers typically comprise ferrite cores. Ferrite core power transformers are far more efficient as contrast with the heavy and lossy iron core transformers that were required in prior art linear power supplies that operated at line frequencies of 50 or 60 Hz.

In most applications, switchmode converters require voltage and / or current loops to regulate the output power from the converter. Housekeeping functions, such as start up modes, over voltage and or over current protection are also typically required. In a switchmode power supply there is generally electronic circuitry on both sides of the power transformer. The common, or

electrical ground, for the input and output side electronics is different and isolation between the two sides must be maintained for both safety concerns and proper operation of the converter. This means that control and timing signals sent across the isolation boundary must also be isolated.

While all of the power to be delivered to the load is transferred across the main power transformer, there can be circumstances, such as at startup, where it is desirable to supply enough energy across the boundary just to power the electronic control circuitry. It is advantageous, for example, to power the controller of fig. 2 (referenced to the secondary side of the converter) at startup, before the main power converter is running. (Specification, paragraph [0004], paragraph lines 7-9). The controller can then have enough available energy at startup to generate control signals that are sent back across the isolation break to the primary side of the converter to control the primary side switches.

In prior art designs, the startup power for the output side electronics is supplied by an open loop startup of the converter, that is transferring initial power through the main power transformer without fully functional feedback and protection controls, or by transferring some energy via an alternate standard cored transformer. Thus, there is a need to power the controller on the secondary side until the primary energy transfer path through the main power transformer comes on. The problem is the extra cost, weight, and surface real estate needed for a second standard transformer for an application that needs relatively small amounts of energy.

The applicant discovered that a coreless transformer embedded in the printed circuit board is a cost effective and efficient solution to powering the secondary side electronics prior to the main converter operation and in certain types of fault conditions. Applicant was able to realize the solution with the additional recognition that high frequency pulses of short duration are needed to transfer the energy required across a low inductance, high leakage coreless transformer.

The exemplary switchmode converter shown in fig 2. illustrates the principle of operation. Oscillator 42 generates well defined high frequency pulses of short duration (typically 100ns) with a repetition period typically on the order of a microseconds (the duty cycle can be varied and the repetition period can be made far longer). In other words, there is a relatively long inactive period following each pulse. The short pulses are needed because longer pulses would present an excessive volt-time product to the low inductance coreless transformer. The pulse repetition rate is set to transfer enough charge to cause smoothing capacitor (C60 in fig. 2) to develop the voltage V_{ccs} that enables and powers the controller. The controller then controls the main power switch or switches (Q500 in fig. 2) through transformer 501. Thus, the secondary side controller causes the power section of the converter (Q500, N1,N2, and N3) to come on as a well behaved closed loop system.

Once the converter has been started, the controller receives power from the main power source (via D701 in fig. 2). Oscillator 42 is then shutdown, as it is no longer required to power the controller. If a fault condition occurs, oscillator 42 can be restarted to bring the converter on again, or to properly handle the fault condition that precludes a successful converter restart. In this mode, the oscillator can be brought on for limited intervals (5 ms for example) and then remain inactive for relatively long periods of time (95 ms for example). It should be noted that within the 5 ms period, there are pulses of relatively short duration (100 ns for example) following by a long inactive period.

The Examiner cites the combination of Shirai with Tolfsen as rendering the invention obvious.

Shirai discloses a switched mode power supply with an alternate transformer (42) to power secondary side electronics. Shirai's secondary transformer is a standard costly cored transformer that requires precious printed circuit board real estate. Shirai teaches a core in the transformer as indicated by the extra two vertical lines indicated on every instance of transformer 42 in the schematic diagrams. The meaning of these lines is well known in the art.

The Examiner proffers Tolfsen as supplying the coreless transformer. But Tolfsen can be distinguished by both the intended mode of operation and by Tolfsen's bifilar structure. Tolfsen teaches an air core transformer designed to deliver continuous power at high voltage. (Tolfsen, fig. 8). Because Tolfsen's transformer transfers relatively high power, Tolfsen's main concern is heating. (Tolfsen, col. 4, lines 6-7). In order to deliver power to the load, Tolfsen teaches a periodic oscillatory waveform. Tolfsen needs this waveform to transfer relatively high power to the high voltage converter output.

Another difference is related to transformer inductance. Because the equivalent inductance of Tolfsen's step up transformer is high, Tolfsen need not address the problem of transferring energy across a low inductance coreless transformer. By contrast, an important aspect of the instant invention is the solution to the problem of transferring energy across a *low inductance* coreless transformer. In fact, the coreless transformer embedded in or on printed circuit board layers was made possible by applicant's recognition of the need to use high frequency pulses of short duration. The far different structure of Tolfsen's air core high voltage transformer does not present a similar problem and thus Tolfsen is silent on the issue of energy transfer across coreless transformers formed in or on the layers of printed circuit boards.

Thus, Tolfsen's waveform and mode of operation both teach away from the use of pulses of short duration, followed by long inactive times used in the inventive technique to transfer energy across a low inductance coreless transformer for signaling and control purposes.

Moreover, in order to achieve good coupling between an air core primary and secondary winding, Tolfsen further teaches the need for bifilar windings. Bifilar winding means that the primary and the secondary windings are coiled together, instead of one complete winding wound over, or adjacent to, another complete winding. In some bifilar construction, the wire of the primary winding is further twisted with the wire of the secondary winding before the two windings are wound together.

By contrast, the inventive transformer is formed on the layers of a printed circuit board (PCB). In the preferred embodiment, the coils are formed on embedded layers of the PCB, thus encapsulating it within the board. This creates a very low cost component since the transformer windings are mere patterns of copper cladding left on the board layer after etching as opposed to separately fabricated discrete components. And rather than bifilar winding, which is more a complex pattern, the coreless transformer employs separate stacked windings insulated by the layers of board dielectric, a far simpler structure.

It can now be seen that Shirai teaches away from the invention by teaching the need for a conventional transformer with a core to power the secondary side circuits. Tolfsen teaches a standard oscillatory drive waveform for a high voltage step up bifilar wound air core transformer. Further, Tolfsen teaches the use of the air core transformer as the primary power source, not for converter output side control and feedback power. And, Tolfsen is silent on issues of startup and control. In fact Tolfsen's rudimentary converter appears to be run completely open loop.

It is believed that the application now fully complies with all provisions of 35 U.S.C. §103. It is therefore respectfully suggested that the application should be allowed.

Respectfully submitted,

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